



DEPARTMENT OF HEALTH & HUMAN SERVICES

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Public Health Service

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Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

May 7, 1997

John O'Grady
USEPA
Office of Superfund
77 W. Jackson Blvd. (SR-6J)
Chicago, Illinois 60604

Dear John:

Here are two (2) copies of the Public Health Assessment for the following site:

Woodstock Municipal Landfill

Please keep one copy for your personal files and place the other copy in your site repository.



If you have any questions, please feel free to contact me at (312) 886-0840.

Sincerely,

Louise A. Fabinski

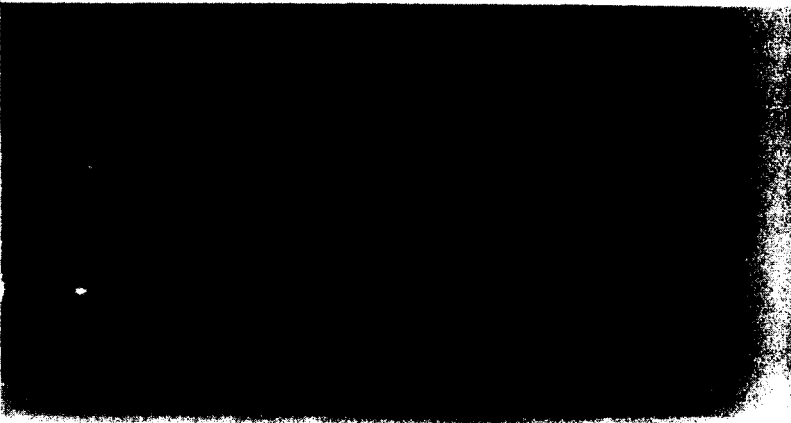

Louise Fabinski
Senior Regional Representative

pg:ATSDR:10/93



**WOODSTOCK MUNICIPAL LANDFILL
WOODSTOCK, MCHENRY COUNTY, ILLINOIS
CERCLIS NO. ILD980605943
APRIL 30, 1997**

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry



PUBLIC HEALTH ASSESSMENT

WOODSTOCK MUNICIPAL LANDFILL

WOODSTOCK, MCHENRY COUNTY, ILLINOIS

CERCLIS NO. ILD980605943

Prepared by

**Illinois Department of Public Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry**

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the U.S. Department of Health and Human Services.

FOREWORD

The Agency for Toxic Substances and Disease Registry, ATSDR, is an agency of the U.S. Public Health Service. It was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the *Superfund* law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and clean up of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. (The legal definition of a health assessment is included on the inside front cover.) If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists then evaluate whether or not there will be any harmful effects from these exposures. The report focuses on public health, or the health impact on the community as a whole, rather than on individual risks. Again, ATSDR generally makes use of existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further research studies are needed.

Conclusions: The report presents conclusions about the level of health threat, if any, posed by a site and recommends ways to stop or reduce exposure in its public health action plan. ATSDR is primarily an advisory agency, so usually these reports

identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Interactive Process: The health assessment is an interactive process. ATSDR solicits and evaluates information from numerous city, state and federal agencies, the companies responsible for cleaning up the site, and the community. It then shares its conclusions with them. Agencies are asked to respond to an early version of the report to make sure that the data they have provided is accurate and current. When informed of ATSDR's conclusions and recommendations, sometimes the agencies will begin to act on them before the final release of the report.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records, and Information Services Branch, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (E-56), Atlanta, GA 30333.

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SUMMARY

The Illinois Department of Public Health (IDPH), in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR), has determined that the 40-acre Woodstock Municipal Landfill National Priorities List (NPL) site in McHenry County, Illinois currently poses no apparent public health hazard since there is presently no exposure to contaminants at levels of health concern. In the future, the site could pose a health threat due to the potential migration of contaminated on-site groundwater to downgradient private wells. In the deep glacial till, on-site groundwater movement has not been well-characterized, and off-site groundwater has not been examined. As a result, it is unknown which private wells to the east, south, or west are downgradient of the landfill and whether site contaminants may reach any of them at levels of health concern. Additional development (business, industrial, and residential) and private wells are likely in the area. If homes or other structures are built on-site, the likelihood of exposure to hazardous substances at levels of health concern will increase; however, existing institutional controls make this unlikely.

Exposure to on-site surface soil by dermal contact, ingestion, or inhalation (dust) is the only completed exposure pathway. However, for the past and present, this exposure is infrequent, of short duration, and probably negligible. Potential exposure pathways include the inhalation of gases and dust, the ingestion of polluted groundwater and sediments, and dermal contact with polluted groundwater, sediments, or surface water.

Citizens have expressed concerns including (1) the possible contamination of municipal and private wells, (2) pollution of Kishwaukee Creek, and (3) possible health effects in children from playing on-site. These concerns are discussed in the Community Health Concerns Evaluation section of this document.

Recommendations of the IDPH include (1) the periodic monitoring of private wells near the site to ensure that no contaminant exposure is occurring at levels of health concern, (2) further characterization of on- and off-site geology and hydrogeology to determine which private wells are downgradient and the likelihood of their contamination, (3) continuation of the existing institutional controls to prevent future on-site construction of homes or other buildings, and (4) continued on-site groundwater monitoring.

BACKGROUND

A. Site Description and History

The Woodstock Municipal Landfill is a 40-acre site in McHenry County, Illinois, Section 17, T44N, R7E, which has been placed on the National Priority Listing (NPL) of the United States Environmental Protection Agency (USEPA). It is approximately 550 feet south of U.S. Highway 14 and about 1,400 feet west of Illinois Highway 47 (Figures 1 and 2). The landfill is on the southern edge of Woodstock and is within the city limits.

The site has had a number of owners since 1935. In 1940, Harry and Eunice Davidson conveyed it to William E. Gaulke, who subsequently sold it to the Woodstock Commission Sales Company for highway purposes. In 1956, the site was sold back to William E. Gaulke, who leased it to the City of Woodstock from 1958 to 1968. In 1968, it was conveyed to the City of Woodstock, the current owner (Warzyn, Inc., 1992).

From 1935 until 1958, the site was a trash dump and open burning area used by unknown people and companies. From 1958 to 1968, it was used for residential garbage and various industrial solid wastes (sources and types mostly unknown). In 1965, the site was converted into a sanitary landfill, and operations continued until 1975, when it was closed. In October 1980, it was placed on the Illinois Environmental Protection Agency (IEPA) "closed and covered" list.

Cover over most of the site consists of 2 to 3 feet of loam, silty loam, silty clay loam, and sandy loam. However, the cover is less than 1 foot thick at one location, and refuse is exposed in some areas. The fill was reportedly 40 percent household and garden refuse and 60 percent industrial waste, mostly of unknown origin. About 12,480 cubic yards of electroplating sludge from Altra Corporation (now Allied Chemical) and 3,000 cubic yards of nickel sludge from Autolite, Woodstock, were reportedly placed in the landfill. A 1964 aerial photograph suggested drums of industrial waste may have been buried in one area. Lime soda sludge was placed in the swampy southern and southeastern portion. Other industrial wastes included automobile batteries and repair-turning chips and grinding files, magnetic powders, metal fabricating solvents, plastics, print shop inks, solvents and type wash, scrap computer tape, waste paint and coating materials, and wastewater treatment sludge. In 1983, IEPA granted the City a permit to landfarm municipal sewage sludge on site, but this practice was stopped in 1988 (Warzyn, Inc., 1992; Hingtgen, 1986; USEPA, 1985; Hughes et al., 1971).

By 1970, leachate seeps were noted on the southern edge of the landfill. In that year, possible treatment of leachate at the soon-to-be-built sewage treatment plant southeast of the site was examined. However, limited leachate analysis found mainly chloride, iron, and total dissolved solids, which sewage treatment would not greatly reduce. Also, the levels of these substances in Kishwaukee Creek were similar upstream and downstream from the site. Closing and covering the landfill in 1976 greatly reduced leachate seeps (IEPA files, 1989). However, a

1985 site inspection by Ecology and the Environment (USEPA contractor), found leachate seeps on the southern part of the landfill (USEPA, 1985).

Between 1970 and 1974, IEPA began corresponding with Woodstock city officials concerning the following violations at the landfill (IEPA files, 1989):

1. indiscriminate dumping near the fence at Davis Road,
2. wood, brush, and combustibles not being covered as required,
3. liquids being deposited on-site, and
4. inadequate cover over final refuse.

A 1972 permit allowed the City of Woodstock to operate the landfill as a solid waste management site. Conditions of the permit required a leachate collection system and a network of monitoring wells. Between 1974 and 1976, IEPA cited the City for the following permit violations (IEPA files, 1989):

1. leachate collection system and monitoring wells were not installed,
2. final cover of the landfill was inadequate,
3. non-permitted sludges from Woodstock Die Cast, Inc., were being dumped, and
4. non-permitted lime sludges from the water treatment plant were being accepted.

On May 21, 1992, the Agency for Toxic Substances and Disease Registry (ATSDR) released an interim preliminary health assessment for the site that was prepared by the Illinois Department of Public Health (IDPH) under a cooperative agreement. The document concluded the site was an indeterminate public health hazard because chemical concentrations in sediment and surface water of Kishwaukee Creek, on-site surface soil, and private wells were unknown.

B. Site Visit

Site visits were conducted on April 12, 1989, and August 31, 1991, by IDPH staff, on November 7, 1991, by IDPH and ATSDR staff, and on December 7, 1993, February 6, 1996, and December 17, 1996, by IDPH staff. The northern and southern sides of the site are fenced; however, it is low and is not an effective barrier to trespassers. Taller chain-link, barbed wire-topped fences around the perimeter of a Farm and Fleet store property (northern part of the eastern side of the site) and wastewater treatment plant (eastern part of the southern side of the site) do not restrict access to the site. In 1991, the northern site fence had signs that read, "Warning; this area contains hazardous materials; no trespassing." By December 7,

1993, these were replaced by "No Trespassing" signs. Brush, grass, and trees cover the landfill, but there are some bare areas and exposed trash. The nearest private wells are about 300 feet north of the northeastern and northwestern corners of the site and serve two residences. Another well near the northwestern corner of the site serves the Door Township Garage. Marshes border Kishwaukee Creek, which is too small to be fished.

On February 6, 1996, large piles of soil about 25 to 30 feet high were on the northwestern part of the site, to be used as cover for the landfill. The low perimeter fence had signs saying, "Warning; Woodstock Landfill; EPA Superfund Site; Authorized Personnel Only; Area Contains Hazardous Chemicals in Soils and Groundwater." The ground had been snow-covered for more than one week, and no human footprints were observed entering the site. Vehicles had entered the site through a locked gate. On the northwestern part of the site, relatively new drums were on a pad. The drums contained primarily soil and used personal protective equipment from the pre-remedial design investigation. Apartments and businesses located about 2,500 feet east of the site, across Route 47, are served by municipal water. Homes about 2,500 feet southeast of the site are served by private wells. On December 17, 1996, the site was essentially unchanged.

C. Demographics, Land Use, and Natural Resource Use

Within a 3-mile radius of the site, rural residences house about 1,500 people (Warzyn, Inc., 1992). The City of Woodstock, 1990 U.S. Census population of 14,353, is primarily north of the site. The land around the site is used for agriculture, commerce, light industry, and residences. Light industry (offices, restaurants, retail stores, and small businesses) is primarily to the east, but also north of the site. Land use north of the site is primarily agricultural and residential, while that to the west is mostly agricultural and undeveloped. Agricultural and marshy land is to the south. According to well logs from the Illinois State Water Survey, there are 51 wells within a 2-mile radius of the landfill (Figure 3). Most of these wells are 50 to 100 feet deep, but one was 40 feet deep (Warzyn Inc., 1992).

The City of Woodstock currently draws water from four municipal wells (Nos. 4, 7A, 8, and 10; Figure 4), which draw from the glacial till. The four wells vary in depth from 114 to 205 feet and are screened below 100 feet. These wells are 2 to 3 miles north of the site. Use of Wells No. 2 and 3 was discontinued in December 1986; use of Wells No. 1 and 7 was stopped in 1989, and use of Wells No. 5 and 6 was halted in 1991. To replace the abandoned wells, two new wells were drilled. Well No. 10 was recently drilled and is currently not in use. Well No. 9 was to be used in 1992, but only 24 hours per month (Warzyn Inc., 1992).

At present, the landfill is owned by the City of Woodstock and is zoned for single family residences. The City has passed a Special Use Permit that restricts use of the site to a city park. While the City currently has no plans to sell the land, this could take place in the future. If homes are built on-site, a City ordinance requires that they be connected to the municipal water supply. Much of the surrounding land is not within the City limits. The population of

McHenry County has been increasing rapidly, and additional development (commercial, industrial, or residential) around the site is likely in the future.

Kishwaukee Creek, at this point a channeled drainage ditch, flows southwest and south of the site. A short distance south and southeast of the landfill, the Woodstock sewage treatment plant releases about 690,000 gallons per day of treated effluent into Kishwaukee Creek. The total flow of water in the stream is about 1 million gallons per day. About 25 miles downstream from the landfill, the ditch becomes the Kishwaukee River, which is used for boating, fishing, and swimming.

In winter, the site is used by snowmobilers, and hunters use wetland areas south of the landfill. Hunting on the landfill has not been documented.

D. Health Outcome Data

The State of Illinois maintains data bases for cancer and birth defects. These data are organized according to zip code and can be used to compare incidence rates of the site zip code to the state as a whole or to a control group. Such a comparison is made if (1) exposure to a chemical(s) is occurring at levels which may cause an adverse health effect(s), (2) the adverse health effect is recorded on one of the state data bases, and (3) many people in a given zip code are exposed. A comparison is also made if the community is concerned a disease rate is elevated and the three conditions above are satisfied.

COMMUNITY HEALTH CONCERNS

A citizen action group, the McHenry County Defenders (MCD), is concerned about possible groundwater contamination of municipal and nearby private wells. Part of their concern also involves the high number of industrial activities in the area. The industrial facilities in the area are beyond the scope of this document. Another concern is the potential for surface water pollution from contaminated groundwater. Since part of the site is in a flood plain, MCD members were concerned that pollution would be washed down Kishwaukee Creek.

Nearby residents are concerned that children playing on-site may experience adverse health effects. Both nearby residents and MCD are concerned about any remedial alternative and the cost involved, particularly because the City of Woodstock is a potentially responsible party. Costs of remediation are beyond the scope of this document.

ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS

The tables in this document list the contaminants of concern. These contaminants will be further evaluated in the remaining sections of this public health assessment to determine if they pose a threat to public health. The listing of a contaminant on the following tables does not

necessarily mean it poses a threat to public health. The selection of these contaminants is based on the following factors:

1. Concentrations of contaminants.
2. Data quality, both in the field and in the laboratory, and the sampling plan design.
3. Comparison of contaminant concentrations and background concentrations with health assessment comparison values for both carcinogenic and noncarcinogenic endpoints (discussed further below).
4. Community health concerns.

Comparison values for a health assessment are levels used to select contaminants for further evaluation. These values, prioritized below, include Environmental Media Evaluation Guides (EMEGs), Cancer Risk Evaluation Guides (CREGs), Reference Dose Media Evaluation Guides (RMEGs), Lifetime Health Advisories (LTHAs), and Maximum Contaminant Levels (MCLs). If a site-related contaminant is found at levels greater than any of these comparison values or if no comparison value exists for the chemical in that medium (air, water, or soil), it will be evaluated further in the remaining sections of the health assessment to determine if it poses a significant threat to public health. Known or suspected human carcinogens with no carcinogenic comparison value will also be listed as a contaminant of concern and will be evaluated in the remaining sections of this public health assessment.

EMEGs are comparison values developed for chemicals that are relatively toxic, frequently encountered at NPL sites, and present a potential for human exposure. They are derived to protect the most sensitive members of the population (e.g., children) and are not cut-off levels, but are comparison values. They do not consider carcinogenic effects, chemical interactions, multiple route exposure, or other media-specific routes of exposure, and are very conservative concentration values designed to protect the public. CREGs are estimated contaminant concentrations based on one excess cancer in a million persons exposed to a chemical over a lifetime (70 years). These are also very conservative values designed to protect sensitive members of the population.

RMEGs are estimates of a daily oral or inhalation exposure to a particular chemical that is unlikely to produce any noncarcinogenic adverse health effects over a lifetime. They are conservative values designed to protect sensitive members of the population.

LTHAs are estimated water concentrations an individual can drink for 70 years without experiencing noncarcinogenic health effects. These numbers contain a margin of safety to protect sensitive members of the population. These values are considered only if no EMEG, CREG, or RMEG is available for the chemical.

MCLs have been established by the USEPA for public water supplies to reduce the chances of adverse health effects from contaminated drinking water. These standards are well below levels associated with health effects and take into account the financial feasibility of achieving specific contaminant levels. These are enforceable limits that public water supplies must meet. These values are considered only if no EMEG, CREG, RMEG, or LTHA is available for the chemical.

The sampling analyses do not indicate the state of chromium detected on and off site. Chromium in the hexavalent state would be a concern in on-site soils and downstream off-site sediments in Kishwaukee Creek.

A. On-site Contamination

1. Air

The levels of chemicals in on-site ambient air are unknown. On November 7, 1990, benzene and other volatile organic compounds were detected in landfill gas (Table 1). There are no comparison values for landfill gas.

2. Leachate

A number of chemicals were found in leachate (Table 2). There are no comparison values for leachate.

3. Groundwater

In background shallow groundwater, benzene, ammonia, arsenic, and manganese were the chemicals of concern (Table 3). Because benzene was found in upgradient wells, five temporary monitoring wells were drilled to determine if the Dorr Township Garage may have been the source. No benzene, ethyl benzene, toluene, or xylenes were found in the temporary wells (Warzyn, Inc., 1992), but other possible contaminants were not examined. In downgradient shallow monitoring wells, benzene, ammonia, arsenic, and manganese were the chemicals of concern (Table 3). With the exception of benzene and arsenic, the levels of chemicals in downgradient wells exceeded those in the background wells.

Benzene and manganese were the compounds of concern in background on-site deep monitoring wells (Table 4). In downgradient deep monitoring wells, ammonia, antimony, arsenic, and manganese exceeded their comparison values. Ammonia, antimony, arsenic, and vinyl chloride levels were higher in downgradient wells than in those upgradient.

4. Sediments and Soils

The concentrations of nickel and zinc in on-site marsh sediments exceeded state, but not regional, background levels (Table 5). The concentrations of inorganic elements in all other

sediment samples were within reported state and regional background levels. Consequently, inorganic elements in sediments will not be further addressed.

The concentrations of chemicals in background surface soil are unknown. In on-site surface soil (depth not reported), benzo(a)pyrene exceeded its comparison value (Table 6). The concentration of silver in on-site surface soil exceeded its comparison value and state background levels (Table 6). For the other inorganic elements, their concentrations did not exceed reported state or regional background levels; consequently, they will not be further discussed.

The concentrations of chemicals in subsurface soil are unknown. Many compounds were found in an on-site buried drum that was not leaking. This was the only intact drum found, and it has been removed. Mercury and high levels of many organic compounds, including polychlorinated biphenyls (PCBs), were found in the drum (Table 7).

5. Surface Water

The concentrations of chemicals in background marsh surface water are unknown. In on-site marsh surface water, arsenic, manganese, and nickel were chemicals of concern (Table 8). ATSDR considers lead a non-threshold hazardous substance, and it will be further evaluated in this document.

6. Biota

The levels of chemicals in on-site animals or vegetation are unknown.

B. Off-site Contamination

1. Air

The concentrations of chemicals in off-site air are unknown. It is also unknown whether soil gas has migrated off-site.

2. Groundwater

Four off-site private wells were sampled: one about 1,500 feet to the northeast (may be upgradient) and three slightly more than 3,000 feet southwest and west southwest (may be downgradient) of the site. Arsenic and manganese were the only chemicals of concern in these wells (Table 10).

3. Sediments and Soil

No organic compounds exceeded comparison values in off-site sediments (Table 5). The concentrations of all inorganic elements in off-site sediments did not exceed reported state or regional background levels; consequently, they will not be discussed further. The concentrations of compounds in off-site surface and subsurface soil are unknown.

4. Surface Water

In background and downstream Kishwaukee Creek surface water, manganese was the only chemical of concern. Its level was only slightly higher downstream of the landfill.

5. Biota

The concentrations of chemicals in off-site plants and animals are unknown.

6. Toxic Release Inventory

Industries must report their air, water, and land emissions of more than 300 toxic chemicals to USEPA. For each of these compounds, a reportable quantity has been established. This information is available through the Toxic Release Inventory (TRI) database. According to the TRI for 1987 to 1991, there were several industries in Woodstock (zip code 60098) that released reportable quantities of toxic substances to the air, surface water, and land (Table 9).

C. Quality Assurance and Quality Control

Warzyn, Inc. (1992) followed acceptable quality assurance/quality control (QA/QC) procedures for chain of custody, blanks, and laboratory procedures. Warzyn, Inc. (1992) used limited permeability testing of the clay under the shallow aquifer coupled with hydraulic gradients to estimate that it would take about 2,000 years for contaminated shallow groundwater to pass through the clay into deeper sand and gravel layers. Considering that contaminants have already reached on-site deep groundwater, this estimate is obviously incorrect; some areas of the clay are evidently more permeable.

Contaminants were found in background shallow and deep monitoring wells by Warzyn Inc. (1992). These wells were immediately adjacent to the landfill and may have been close enough to the waste to have been affected by the downward leaching of contaminants. In addition, the Door Township Garage is a likely source of benzene in these wells. Other wells were drilled further upgradient, but they were sampled only for benzene, toluene, ethylbenzene, and xylenes. This makes comparisons of background and downgradient concentrations difficult.

Warzyn, Inc. (1992) assumed that landfill gas would move upward through the cap rather than laterally through off-site soil; however, chemicals in off-site soil gas were not measured to verify their hypothesis.

Warzyn, Inc. (1992) concluded that on-site shallow groundwater tends to move downward into the deeper glacial till. However, as indicated by the water level measurements for three monitoring well nests (MW-1, MW-4, MW-9), this was not always the case. At these locations, there was often little or no vertical hydraulic gradient, and on several occasions, deep groundwater was moving upward into the shallow aquifer.

Groundwater flow in the deep groundwater was not examined by Warzyn, Inc. (1992), although water elevation measurements were taken. This was a major omission, considering that most wells in the area use this water. This made it difficult to examine the likelihood of contamination of nearby wells.

The depth of surface soil sampling was not given in Warzyn, Inc. (1992). Only the top two inches are important for current exposure, while exposure to deeper subsurface soil is possible if erosion or other disturbance of the cap occurs. In addition, no background soil or marsh surface water samples were taken. Consequently, for these media, site contaminant levels could not be compared to site-specific background concentrations.

For other documents, IDPH relied on the information in them. IDPH assumed that adequate QA/QC measures were followed regarding chain-of-custody, laboratory procedures, and data reporting. The analyses, conclusions, and recommendations in this health assessment are valid only if the referenced documents are complete and reliable.

D. Physical and Other Hazards

Exposed refuse in some areas of the landfill is a physical hazard. In one leachate vent, Warzyn, Inc. (1992) found that the combustibility of landfill gas was 33 percent of the lower explosive limit (LEL; the level at which it becomes flammable). In a confined space (e.g., in a building), USEPA recommends evacuation when the combustible gas level reaches 10 percent of the LEL, and the Occupational Safety and Health Administration considers air with this level of combustible gas a hazardous atmosphere. Consequently, if buildings are constructed on-site in the future (zoned for residential housing), explosive concentrations of landfill gas may accumulate in them. The present institutional controls, however, should prevent this on-site construction from occurring.

PATHWAY ANALYSES

A hazardous chemical can affect people only if they contact it through an exposure pathway at a sufficient concentration to cause a toxic effect. This requires a source of exposure, an environmental transport medium, a route of exposure, and an exposed population. A pathway

is complete if all of its components are present and people were exposed in the past, are currently being exposed, or will be exposed in the future. If (1) parts of a pathway are absent, (2) data are insufficient to determine if it is complete, or (3) exposure may occur at some time (past, present, future), then it is a potential pathway. The exposure pathways at this site are summarized in Table 11.

A. Completed Exposure Pathways

1. Soil

Surface soil of the landfill may be contaminated by leachate (described in Groundwater subsection under Potential Pathways) or direct contact with wastes. Organic compounds which do not dissolve easily in water can be tightly adsorbed to soil organic matter and exhibit low mobility in the soil profile, although they may be more mobile in sandy soils with low organic matter content.

On-site workers or trespassers may be exposed to chemicals in on-site surface soil by dermal contact and incidental ingestion (past, present, future). Although two homes are located across the road from the site, the low fence on this northern side may inhibit site access to small children. However, the low fence would not inhibit site access to teenagers or adults. Most of the site is well-vegetated, which would minimize the exposure to soil. Furthermore, the exposure of trespassers or on-site workers is probably infrequent and likely negligible. In the future, remediation workers may be exposed to contaminants in surface or subsurface soil. These exposure pathways warrant the use of protective equipment by remediation workers.

The current institutional controls prohibit the construction of homes or other buildings on-site. In the future, if these controls are eliminated and homes are constructed on-site, the exposure of people to actual or possible soil contaminants is more likely. Excavation may expose uncharacterized chemicals in subsurface soil and possibly expose people to these chemicals by dermal contact, incidental ingestion, and inhalation (dust).

B. Potential Exposure Pathways

1. Air

Volatile organic compounds from the wastes can dissolve in groundwater or move through soil gas. This gas can migrate to the surface or laterally through the soil. Warzyn, Inc. (1992) said that soil gas probably moves out through the landfill cap rather than laterally through the soil because it is likely to follow the path of least resistance (through the thin cap); however, the concentrations of chemicals in soil gas around the landfill have not been measured to verify this hypothesis. In the future, if a less permeable cap is placed on the landfill to reduce leachate production, it may promote the lateral spread of landfill gas through the surrounding soil. If soil gas from the landfill reaches buildings, it may seep into them. Occupants may then inhale contaminants. Volatile organic compounds are emitted into the air through the

landfill cap, where they are diluted by the ambient air. Consequently, exposure to undiluted landfill gas emitted through the cap will not occur. Exposure to diluted landfill gas in the ambient air will probably be of short duration and not likely to cause adverse health effects. Most of the site is well-vegetated, so the production of airborne dust is probably also negligible.

Presently, there are no on-site buildings where landfill gas could accumulate. If buildings are constructed on-site in the future, landfill gas may enter them and expose occupants to these chemicals by inhalation and dermal contact. In addition, if landfill gas should accumulate in buildings, it may reach a flammable concentration. This warrants the continuation of institutional controls to prevent the construction of homes or other buildings on-site.

2. Groundwater

Water from precipitation can infiltrate through the cap of the landfill (this movement is enhanced by sand and gravel, but inhibited by clay). A landfill cap which is relatively flat, thin, and has depressions tends to decrease runoff and promote infiltration. Warzyn, Inc. (1992) concluded that most runoff does not leave the site, and that precipitation tends to infiltrate. If infiltrating water contacts wastes in the landfill, it can dissolve contaminants and become leachate. Similarly, if groundwater flows into the landfill and contacts waste, it can become contaminated.

Some chemicals are transported more easily by groundwater than others. In groundwater, the heavy metals cadmium, copper, lead, nickel, and zinc are not very mobile because they do not dissolve easily in water and are strongly adsorbed to geologic material or tend to form precipitates. Consequently, high concentrations of heavy metals generally occur close to landfills. Attenuation of organic compounds by subsurface geologic materials is generally small in aquifers with low organic carbon content (Christensen et al., 1994). Organic compounds which dissolve the most easily in water are generally the most mobile in groundwater. Organic compounds can also be broken down into other chemicals (Christensen et al., 1994), that may be more or less toxic.

The flow of leachate into the surrounding groundwater and the flow of groundwater are controlled by the geology of the site. Plumes of contaminated groundwater usually extend no more than about 3,300 feet from a landfill (Christensen et al., 1994). The site geology consists of glacial till 200 to 250 feet thick overlying dolomite bedrock. The uppermost layer of glacial till is sand and gravel, with some silt and occasional peat. It is 40 to 50 feet thick in the northern part of the site, but thins to about 20 feet in the southwestern part and less than 5 feet near monitoring well MW-3. Under the surficial sand and gravel is the Yorkville till, which consists of clay with some sand and gravel. The next layer is the Tiskilwa till, which is composed of clay with some sand and gravel. On-site, the thickness and depth of the Tiskilwa till are unknown. Both the Yorkville and Tiskilwa tills have interbedded layers and lenses of sand and gravel. While clay inhibits groundwater movement, sand and gravel layers promote the lateral flow of water and dissolved contaminants.

The water table is in the surficial sand and gravel layer. All of the shallow monitoring wells sampled water from this layer. Shallow groundwater mainly flows to the south, from the area of higher groundwater elevation to the area of lower groundwater elevation (Figure 2). In the southern part of the site, the sand and gravel thins as the ground surface becomes lower, and groundwater discharges into on-site marshes. South of the site, shallow groundwater flows into Kishwaukee Creek during all seasons (wet or dry). Consequently, chemicals in shallow groundwater may be discharged into Kishwaukee Creek. Groundwater also moves away from the wastewater treatment plant lagoon, which has an area of higher groundwater elevation (a groundwater mound).

Deep groundwater flow was not examined by Warzyn, Inc. (1992); however, their limited measurements indicate that it is more complex. Along the northern edge of the site, groundwater moves to the south. For the rest of the site, the data are too limited for basing any conclusion, but deep groundwater does not simply move to the south like the shallow groundwater. Warzyn, Inc. (1992) reported that shallow groundwater tends to move downward into the lower glacial till; however, this is not always the case. At monitoring well clusters MW-1, MW-4, and MW-5 (Figure 2), there was little or no vertical gradient, and on several occasions, deep groundwater was moving upward into the shallow groundwater. The lack of a vertical gradient suggests that shallow and deep groundwater may be hydraulically connected in these areas. The clay under the surficial sand and gravel is relatively impermeable, but its continuity around the site is unknown. Furthermore, the presence of contaminants in deep groundwater indicates that it has not stopped the downward movement of pollutants. Exposure to contaminated on-site groundwater is not occurring and is unlikely to occur. Even if the existing institutional controls are lifted and homes or other buildings are constructed on-site, a City ordinance will require that they be served by the municipal water supply. Because of dilution by groundwater, it is unlikely that chemicals would reach downgradient private wells at the same levels found on-site.

The groundwater of the deeper glacial till is used by most of the surrounding private wells. In McHenry County, only 7 percent of the groundwater is drawn from bedrock aquifers; most of it comes from the glacial till. Deep groundwater does not flow northward from the site and the Woodstock municipal wells are a considerable distance from the site, so they should not become contaminated by the landfill. The direction of flow in the rest of the site is uncertain, and that of off-site deep groundwater is unknown. Consequently, it is uncertain which private wells to the east, south, or west are downgradient of the site and may potentially be contaminated. In the future, additional development (business, industrial, or residential) and more private wells are likely in the unincorporated areas around the site. If private wells become contaminated, people may be exposed to pollutants by dermal contact, inhalation of volatile organic compounds during showering and other water use activities, and ingestion.

3. Sediments

Surface soil of the landfill may be contaminated by leachate or direct contact with wastes. Then, polluted surface soil may be eroded from the landfill. This may contaminate sediments of on-site marshes and Kishwaukee Creek off-site. Also, chemicals in leachate may move

through groundwater to the on-site marshes or Kishwaukee Creek, which may pollute their sediments.

On-site workers or trespassers may be exposed to chemicals in on- or off-site sediments by dermal contact and incidental ingestion (past, present, future). For the past and present, these exposures are probably infrequent and likely negligible. If residences are constructed on-site in the future, the likelihood of exposure to contaminated sediments will increase. This is especially true for children, who like to play in streams and wetlands. Remediation workers may be exposed to contaminated sediments by dermal contact and incidental ingestion. These potential exposures warrant the use of protective equipment by remediation workers and the continuation of the existing institutional controls to prevent the construction of homes or other buildings on-site.

4. Surface Water

As previously described for sediments, surface water may become contaminated by runoff from the landfill or polluted groundwater. Covering the landfill in 1976 greatly reduced leachate seeps in the southern part of the site. Consequently, the concentrations of contaminants in Kishwaukee Creek and on-site marshes may have been higher in the past, before the landfill was covered. On-site workers and trespassers may be exposed to chemicals in surface water by dermal contact (past, present, future). Few people would deliberately drink surface water, so its consumption will not be further discussed. The exposure of trespassers and on-site workers is probably infrequent and may be negligible. If residences are built on-site in the future, the likelihood of exposure to contaminated surface water will increase, with dermal exposure the most likely route. This is especially true for children, who like to play in streams and wetlands. Because dermal exposure is the primary route of concern, chemicals in surface water that cannot penetrate the skin (arsenic and manganese) will not be discussed further. Remediation workers may be exposed to contaminated surface water (future). These pathways warrant the use of protective equipment by on-site workers and continuation of the existing institutional controls to prevent the construction of homes or other buildings on-site.

5. Biota

The environmental pathways for the contamination of soil, sediments, or surface water have been previously described. With the exception of PCBs, the site contaminants should not accumulate in plants or animals. PCBs were found in only an intact buried drum, which was removed. Consequently, human exposure to contaminants in plants or animals is not of concern and will not be further discussed.

PUBLIC HEALTH IMPLICATIONS

A. Toxicological Evaluation

To evaluate potential health effects, the estimated exposure doses to site-related compounds were compared with health effects information in the literature, primarily ATSDR Toxicological Profiles. ATSDR and USEPA have developed chemical-specific guidelines for evaluating the potential for adverse health effects of chemicals in air, water, and soil. ATSDR has developed Minimum Risk Levels (MRLs) to evaluate non-cancerous health effects. An MRL is an estimate of the daily human exposure to a contaminant below which non-cancerous adverse health effects are unlikely to occur. The exposure is expressed as milligrams of chemical per kilogram of body weight per day (mg/kg/d). MRLs are developed for both the oral and inhalation routes of exposure. They are also developed for different lengths of exposure, such as acute (14 days or less), intermediate (15 to 365 days), and chronic (more than 365 days). A USEPA Reference Dose (R_fD) is an estimate of the daily exposure (mg/kg/d) to the general public that is likely to be without an appreciable risk of deleterious noncancerous effects during a lifetime. USEPA has also developed health advisories for exposure to drinking water for periods of one-day, ten-day, longer-term, and lifetime exposures.

USEPA also evaluates the potential of a chemical to cause cancer effects over a lifetime. To do this, they have estimated cancer slope factors for certain chemicals with sufficient toxicological information on cancerous effects. These cancer slope factors are estimates of the potency of a chemical to cause cancer and are used to estimate the cancer risk of specific doses. These risk estimates are extremely conservative and are meant to protect susceptible members of the public. There is a 95 percent probability the actual risk is no higher, is probably lower, and may be zero. Furthermore, cancer risk estimates are extrapolated to low doses from high dose animal or human (usually occupational exposure) studies. This approach is somewhat controversial. Some researchers believe body repair mechanisms can handle low doses, and that higher doses are needed to cause cancer. Some people also question the validity of high to low dose extrapolation. Until more information on carcinogenesis becomes available, USEPA takes the conservative approach that there is no threshold and any exposure to a carcinogen carries a finite risk.

USEPA has established a weight-of-evidence classification system for carcinogens based on the adequacy and consistency of the available human and animal data. Group A compounds are known human carcinogens (usually occupational exposure). Group B1 chemicals are probable human carcinogens based on limited human data. Group B2 compounds are probable human carcinogens based on sufficient evidence in animals, but inadequate or no evidence in people. Group C chemicals are possible human carcinogens based on limited data. Group D compounds are not classifiable as to human carcinogenicity because of inadequate or no data. For group E chemicals, there is evidence they do not cause cancer.

In the exposure estimate calculations for drinking water, consumption was 1 liter per day for children and 2 liters per day for adults. Soil ingestion rates were 5,000 milligrams per day for

pica children and 100 milligrams per day for adults. Body weights were 10 kilograms for children and 70 kilograms for adults. For residents, daily exposure was assumed.

1. Organic Chemicals

a. Benzene

Benzene was a chemical of concern in background and downgradient on-site shallow groundwater, and background on-site deep groundwater. Benzene can be absorbed after inhalation, ingestion, or dermal contact. Most of the reported health effects have been observed after inhalation exposure, and, unfortunately, little information is available regarding exposure by other routes (ATSDR, 1995a).

Oral exposure to on- or off-site levels of benzene in groundwater should not cause noncancerous health effects. There is sufficient evidence that benzene can cause leukemia after inhalation, but it is uncertain whether it can cause cancer after oral or dermal exposure (ATSDR, 1995a). While leukemia has been seen in rats after oral gavage exposure, the type of leukemia is different from the one observed in humans. The kind of leukemia observed in humans is rare in rodents (ATSDR, 1995a). USEPA has classified benzene as a known human carcinogen (Group A). Using the animal data, USEPA derived a cancer slope factor that can be used for estimating the cancer risk of specific doses. Lifetime consumption of on-site shallow or deep groundwater with the maximum detected benzene concentration would result in an estimated no apparent increased cancer risk. Exposure to contaminated on-site groundwater is not occurring and is unlikely to occur. Because of dilution by groundwater, it is unlikely that benzene would reach downgradient private wells at the same levels found on-site.

b. bis(2-Ethylhexyl) Phthalate

Bis(2-ethylhexyl) phthalate was found in downgradient on-site shallow groundwater and on-site marsh sediments. It is readily absorbed after inhalation or ingestion, and some is also absorbed after dermal contact (ATSDR, 1991b). After absorption, most of it is converted into monoethylhexyl phthalate and 2-ethylhexanol. These compounds go to the kidneys, liver, and testes, and small amounts are stored in fats. Most of these chemicals are eliminated from the body within 24 hours (ATSDR, 1991b).

Consumption of downgradient on-site shallow groundwater with the highest concentration of bis(2-ethylhexyl) phthalate by a child or on-site marsh sediments by a pica child (one who displays a tendency to eat dirt) would not exceed the USEPA chronic R_d, so noncancerous health effects are not expected. In mice and rats, bis(2-ethylhexyl) phthalate can cause liver cancer (ATSDR, 1991b), and USEPA has classified it as a probable human carcinogen (Group B2). USEPA has developed a cancer slope factor that can be used to estimate the cancer risk of specific doses. Lifetime consumption of water with the highest concentration in downgradient shallow groundwater would result in an estimated no apparent increased risk of

cancer. Exposure to on-site groundwater is not occurring and is unlikely to occur. It is unlikely that bis(2-ethylhexyl) phthalate would reach downgradient private wells at the same concentrations found on-site. Lifetime ingestion of soil with the maximum level of bis(2-ethylhexyl) phthalate in on-site marsh sediments would result in an estimated insignificant or no increased risk of cancer.

c. Butylbenzyl Phthalate

This compound was found only in on-site surface soil. Consumption of soil with the highest concentration of butylbenzyl phthalate would not exceed the chronic R_{CD} for a pica child, so noncancerous health effects from on-site exposure are not expected. There is no cancer slope factor for butylbenzyl phthalate. There have not been any cancer studies of people exposed to butylbenzyl phthalate, and animal evidence is inadequate to classify its ability to cause cancer (HSDB, 1993).

d. Dimethyl Phthalate

This compound was found only in on-site surface soil. It can be absorbed after inhalation, ingestion, or dermal contact (HSDB, 1993). Health effects in animals or humans have been observed only at much higher doses than possible from on-site soil. On-site exposure would also be much lower than the exposure from its common use as a mosquito repellent (HSDB, 1993)

e. 4-Methylphenol (p-Cresol)

4-Methylphenol was found in on-site marsh sediments. It can be absorbed after dermal contact, inhalation, or ingestion. Most absorbed 4-methylphenol is eliminated from the body within one day (ATSDR, 1990b). Consumption of soil with the greatest level in on-site marsh sediments would not exceed the acute MRL for children or adults. Consequently, noncancerous health effects are not expected. There are no cancer studies in humans or animals following oral exposure to methylphenols; however, one short-term animal study suggested that they may act to promote cancers from other causes (ATSDR, 1990b). USEPA has classified it as a possible human carcinogen (Group C). Past and present exposure to on-site marsh sediments has probably been negligible; however, exposure may increase in the unlikely event that homes are built on-site.

f. Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are common products of combustion and were found only in on-site surface soil. With the exception of benzo(a)pyrene, which was a chemical of concern, no soil comparison values were available for benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)pyrene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, or phenanthrene. PAHs can be absorbed after inhalation, ingestion, or dermal contact (ATSDR, 1993). Many of the PAHs are classified as probable human carcinogens (Group B2) by

USEPA. People occupationally exposed to mixtures of PAHs have developed lung (inhalation) and skin (dermal contact) cancer; however, because of exposure to other chemicals, PAHs could not be established as the cause. Benz(a)anthracene can cause skin cancer in mice (dermal exposure). In animals, benzo(a)pyrene can cause many types of tumors, including cancers of the larynx, nasal cavity, pharynx, trachea (inhalation exposure), skin (dermal exposure), breast, forestomach, and lung, as well as leukemia (ingestion exposure). Benzo(b)fluoranthene can cause skin cancer after dermal application. Chrysene can cause skin cancer in animals after dermal administration, but tumors after other routes of exposure have not been investigated. Dibenz(a)anthracene can cause skin cancer (dermal exposure), and there is some evidence it can cause cancer after oral exposure. Mixtures of PAHs, such as coal tar, can also cause cancer in animals. Anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, and pyrene cannot cause cancer in animals when administered alone (ATSDR, 1993).

USEPA has developed a cancer slope factor for benzo(a)pyrene, as well as relative potency factors for the other carcinogenic PAHs. Using these numbers, the cancer risk from lifetime consumption of on-site surface soil with the highest concentration of PAHs would result in an estimated no apparent increased risk of cancer. For benzo(a)pyrene, daily ingestion of on-site surface soil with the highest level would not exceed the chronic oral MRL for a pica child or adult; so, noncancerous health effects are not expected. Noncancerous health effects of other PAHs have not been well-investigated, but observed effects occurred at much higher doses than possible from on-site soil (ATSDR, 1993).

g. Vinyl Chloride

Vinyl chloride was found only in on-site deep groundwater. It can be produced by the breakdown of other volatile organic compounds, including tetrachloroethene, trichloroethane, and trichloroethene. Vinyl chloride can enter the body after inhalation or ingestion, but little is absorbed after skin contact. If absorbed by a pregnant woman, it can cross the placenta and enter the blood of a fetus. After absorption, most of it is eliminated from the body within one day. However, some of it is converted into other chemicals, which are often more toxic and are eliminated more slowly (ATSDR, 1995c).

Drinking water with the maximum concentration of vinyl chloride found in on-site deep groundwater would exceed the chronic oral MRL for children and adults. In animals, chronic oral exposure to vinyl chloride can cause liver damage and liver cancer. Increased liver cancer rates have been reported in several studies of workers exposed to vinyl chloride. Other cancers that were found to be elevated in at least some studies include cancers of the brain and central nervous system, lung and respiratory tract, and the lymphatic and blood systems. One study of exposed female workers found they had higher rates of leukemia, lymphomas, and stomach cancer than males (ATSDR, 1995c). USEPA has classified vinyl chloride as a known human carcinogen (Group A). The available data are insufficient to estimate the possible cancer risk of vinyl chloride from specific doses. No one is drinking on-site groundwater, and it is unlikely that vinyl chloride would reach downgradient private wells at the same

concentrations found on-site. It is uncertain whether it may reach private wells at levels of concern.

2. Inorganic Chemicals

a. Ammonia

Ammonia was a chemical of concern in background and downgradient shallow on-site groundwater, and downgradient deep groundwater. It can be absorbed after inhalation or ingestion, and a small amount may be absorbed if liquid ammonia is spilled on the skin (ATSDR, 1989a). Consuming background shallow groundwater, on-site shallow groundwater, or downgradient on-site deep groundwater with the highest concentration of ammonia would exceed the intermediate MRL for children.

In rats, ammonia caused increased water intake and reduced food intake in weanlings, and decreased body weight in adults who drank ammonia in water at levels about 43 times higher than those in on-site groundwater. In rabbits, oral exposure to ammonia at levels about 57 times higher than found in on-site groundwater caused enlarged adrenal glands. No one is drinking on-site groundwater, and it is unlikely that ammonia would reach downgradient private wells at the same concentrations found on-site. It is unknown whether ammonia may reach private wells at levels of concern.

There have not been any studies of cancer in humans following oral ammonia exposure. Studies in mice have not shown a link between ammonia consumption and cancer. Colorectal cancer incidence, however, may be influenced by ammonia concentrations in the gut. Cancer and polyp incidences are highest in areas of the colon having the highest ammonia concentrations (ATSDR, 1989a).

b. Antimony

Antimony was a chemical of concern in downgradient on-site deep groundwater. It can enter the body after ingestion or inhalation (ATSDR, 1990a). Ingestion of water with the maximum level in on-site deep groundwater by children would exceed the chronic RfD. Chronic antimony exposure may irritate the eyes, lungs, and skin, as well as cause diarrhea, heart problems, and vomiting (ATSDR, 1990a). While animals have contracted lung cancer after breathing antimony dust, there are no animal or human cancer studies after chronic ingestion of antimony (ATSDR, 1990a). Consequently, it is uncertain whether it may cause cancer after ingestion. No one is drinking on-site groundwater, and it is unlikely that it would reach downgradient private wells at the same concentrations found on-site. It is unknown whether it may reach private wells at levels of concern.

c. Arsenic

Arsenic was a chemical of concern in background and downgradient on-site shallow groundwater, downgradient on-site deep groundwater, and off-site private wells. Arsenic can

be absorbed after inhalation or ingestion. While large amounts are harmful, small quantities of arsenic may be beneficial. Inhalation of arsenic increases the risk of lung cancer (ATSDR, 1991a). Oral exposure to arsenic has been linked to an increased incidence of skin cancer in people (ATSDR, 1991a). USEPA has classified arsenic as a known human carcinogen (Group A). They have developed a cancer slope factor for arsenic that can be used to estimate the risk from consumption of specific doses. Lifetime consumption of background shallow groundwater, on-site shallow groundwater, downgradient deep on-site groundwater, or water from off-site private wells with the maximum arsenic concentration would result in an estimated moderate increased risk of cancer. People are being exposed to arsenic in private wells, and this exposure may result in an unacceptable cancer risk. However, as previously discussed, these risk estimates are extremely conservative and may overestimate the actual risk.

The ingestion of background or on-site shallow groundwater, as well as deep groundwater would exceed the MRL for children, while only background shallow groundwater would exceed the MRL for adults. Ingestion of arsenic can cause areas of skin pigmentation (ATSDR, 1991a). In the body, arsenic is converted into methyl arsenic or dimethyl arsenic by enzymes, and these latter compounds are less toxic and more easily excreted. It is uncertain what intake of arsenic can be detoxified by this process, but limited data indicate the enzymes may begin to be saturated (i.e., cannot convert at a faster rate) at doses of 0.003 to 0.015 milligrams per kilogram per day. Consequently, doses less than 0.001 milligrams per kilogram per day are likely to pose little risk of noncancerous health effects (ATSDR, 1991a). Drinking background shallow groundwater would exceed this level for children, but not adults. However, consumption of this water is unlikely.

d. Manganese

Manganese was a chemical of concern in background and downgradient shallow and deep on-site groundwater, and off-site private wells. Manganese can be absorbed after ingestion or inhalation. Only about 3 to 5 percent of ingested manganese is absorbed, but the amount absorbed after inhalation is unknown. It is believed the small amounts consumed by people in a typical diet are important to their health, but high concentrations are harmful (ATSDR, 1990c). There is controversial evidence that elevated manganese levels similar to those found on-site may be able to cause brain damage, with symptoms such as weakness, stiff muscles, and trembling of the hands. However, other chemicals may have been involved, and it is uncertain whether manganese was the cause (ATSDR, 1990c).

Consumption of background and on-site shallow groundwater with the highest manganese concentration would exceed the chronic oral R_fD for children and adults, while ingestion of on-site deep groundwater would exceed the R_fD only for children. However, no one is likely to drink on-site groundwater.

e. Nickel

Nickel was a chemical of concern in on-site marsh surface water. Nickel can be absorbed after ingestion or inhalation, and a small amount can be absorbed after dermal contact. Within a

few hours after exposure, most dermally applied nickel penetrates the surface layers of the skin and is contained in deeper layers. In one animal study, skin nickel levels were not elevated 24 hours after dermal exposure. Most ingested nickel is not absorbed, but is eliminated in the feces. Regardless of the exposure route, after absorption, most nickel is transported to the kidneys and is eliminated in the urine over a period of days. Small amounts of nickel are essential to the health of animals and probably also of people (ATSDR, 1995b). Lung and nasal cancer have been observed after occupational exposure (ATSDR, 1995b); however, these people were exposed to much higher levels than are likely on-site. In two mouse studies, nickel did not cause cancer after oral exposure, and there is no information about cancer in animals or people after dermal exposure. The National Toxicology Program has classified nickel as reasonably anticipated to be a carcinogen.

Dermal exposure to levels of nickel similar to those in on-site marsh surface water can cause an allergy. Sensitized individuals then exhibit skin dermatitis after being dermally exposed to nickel (ATSDR, 1995b). For the past and present, exposure to on-site marsh surface water is probably infrequent, and significant future exposure is also unlikely, because existing institutional controls restrict future use to a city park.

f. Silver

Silver was a chemical of concern in on-site surface soil. It can be absorbed after ingestion, inhalation, or dermal contact (ATSDR, 1989b). Ingestion of on-site surface soil with the greatest level of silver would exceed the chronic oral R_{fd} for a pica child, but not an adult. A pica child, however, is not likely to have access to the site. Long-term exposure to silver may cause gray or blue-gray skin discoloration in people, but the required dose is uncertain. Other health effects of silver (ATSDR, 1989b) occurred only at levels much higher than possible from on-site exposure.

B. Health Outcome Data Evaluation

No health studies have been performed on people around the Woodstock Municipal Landfill. For the past and present, there is no evidence that people have been exposed to hazardous chemicals from the site at doses which may result in adverse health effects. For the past and present, the exposure of trespassers and on-site workers has probably been infrequent and likely negligible. Aside from Kishwaukee Creek, any off-site pollution is unknown. Dermal exposure to manganese, the only chemical elevated in Kishwaukee Creek, is not of health concern. Therefore, no health study of surrounding residents or on-site workers is warranted at this time. In the future, if new data suggest that exposure to hazardous chemicals is or was occurring at levels which may cause adverse health effects, the need for health studies will be reevaluated.

C. Community Health Concerns Evaluation

One citizen concern is the possible future contamination of municipal and private wells. The Woodstock municipal wells are north of the site, and deep groundwater flows to the south at the northern edge of the landfill. The municipal wells are also 2 to 3 miles from the site, and plumes of contaminated groundwater generally extend no more than about 3,300 feet from a landfill (Christensen et al., 1994). Consequently, the municipal wells should not become contaminated by the site. Because the off-site hydrogeology is unknown and that of on-site deep groundwater has not been well-characterized, it is not known (1) which private wells to the east, south, or west are downgradient or (2) whether contaminants may reach downgradient wells at levels of concern.

Another concern is that Kishwaukee Creek may be polluted by the landfill. Shallow groundwater from the site is discharging into on-site marshes and Kishwaukee Creek. In addition, contaminated surface soil may be washed into the stream. Before the landfill cap was completed in 1976, more leachate seeped to the surface in the southern part of the landfill. This may have increased the concentrations of chemicals in Kishwaukee Creek. Much of the area along the creek is marshy, which would inhibit access. For the past and present, because there are few residences near the site and stream, it is likely that few people have been exposed to contaminants in Kishwaukee Creek. In the future, if homes are constructed near the creek, more people, especially children, may be exposed, with dermal exposure the primary route. Manganese was the only chemical elevated in Kishwaukee Creek surface water, and dermal exposure to it is not of concern. No chemicals were found above background levels in Kishwaukee Creek sediments. Consequently, adverse health effects are not expected from dermal exposure to its sediments or surface water.

Another citizen concern is that children playing on-site may experience adverse health effects. At this time, exposure of teenagers or adults on-site is more likely than small children. Pica children are usually less than six years of age, and with the present site fencing, their access to the site is unlikely. At this time, the exposure of trespassers is probably sporadic and negligible. Unless the existing institutional controls restricting use of the site are lifted, future residential use of the site will not occur. If this should occur, the exposure of children to contaminated sediments, surface soil, and surface water is more likely. In addition, on-site excavation could expose potential contaminants that may now exist in subsurface soil. People may then be exposed to contaminants in surface soil through dermal contact, incidental ingestion, and inhalation (dust). City water would be required on-site, which would prevent exposure to contaminated on-site groundwater. Landfill gas may pose a danger by possibly entering future homes or other buildings on-site and exposing the occupants to hazardous contaminants and possibly explosive concentrations.

CONCLUSIONS

The Woodstock Municipal Landfill currently poses no apparent public health hazard because there is presently no exposure to contaminants at levels of public health concern. In the future, the site could pose a health threat due to the potential migration of contaminated on-site groundwater to downgradient private wells. In the deep glacial till, on-site groundwater movement has not been well-characterized, and that off-site has not been examined; as a result, it is unknown which private wells to the east, south, or west are downgradient of the landfill and whether site contaminants may reach any of them at levels of concern. Because the Woodstock municipal wells are 2 to 3 miles upgradient of the site, they are not likely to become contaminated by it.

Past and present exposures of nearby residents, on-site workers, and trespassers to on-site contaminants were and are probably infrequent and negligible. The continuation of existing restrictions against the future on-site construction of homes or other structures is warranted. During site remediation activities, dust reduction methods should be employed and site workers should use proper protective equipment to prevent exposure to contaminants.

RECOMMENDATIONS

1. Conduct periodic monitoring of private wells that are closest to the site (east, south, and west of the site) to ensure that no exposure is occurring to hazardous substances at levels of public health concern.
2. Determine which private wells using the deeper glacial till aquifer are downgradient of the site and the likelihood of their contamination.
3. Maintain the existing institutional controls to prevent the construction of homes or other structures that would compromise the cap and would likely cause exposure to on-site contaminants. In addition, landfill gas may penetrate into any future buildings constructed on the landfill and create a health and flammability hazard.
4. Assure the use of proper protective equipment and dust reduction methods by on-site workers during excavation or other remediation activities that disturb the landfill cap.
5. Continue periodic monitoring of on-site wells to detect possible changes in contaminants, their concentrations, and migration.

HEALTH ACTIVITIES RECOMMENDATIONS PANEL STATEMENT

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act, as amended, the Woodstock Municipal Landfill site has been evaluated for appropriate follow-up with respect to health activities. There is no evidence that people are or have been exposed to site-related contaminants at levels of health concern. Consequently, no health studies are warranted at this time. If on-site groundwater contamination reaches private wells in the future, the site will be reevaluated for follow-up health actions.

PUBLIC HEALTH ACTIONS

Based on the recommendations made in the health assessment, the following public health actions have been or will be done:

1. IDPH will conduct community health education to assist residents in understanding their potential for exposure.
2. No health studies are warranted at this time. In the future, if new data indicate that exposure to potentially harmful levels of chemicals is occurring, the need for follow-up health studies will be reevaluated.

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APPENDIX A. FIGURES

Figure 1. The Woodstock Municipal Landfill and vicinity (Marzyn, Inc., 1992).

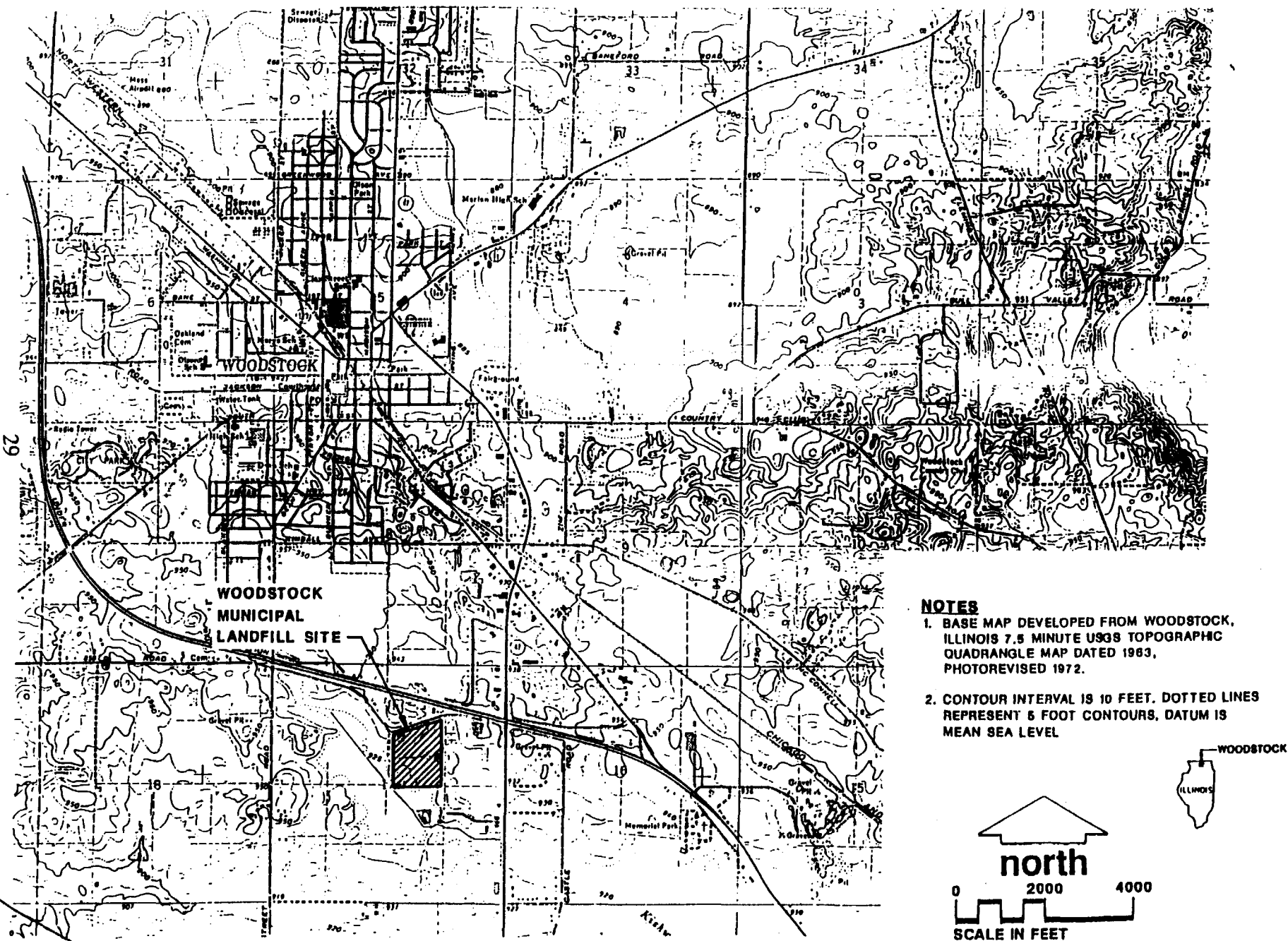


Figure 2. Shallow groundwater flow at the Woodstock Municipal Landfill
(Harzyn, Inc., 1992).

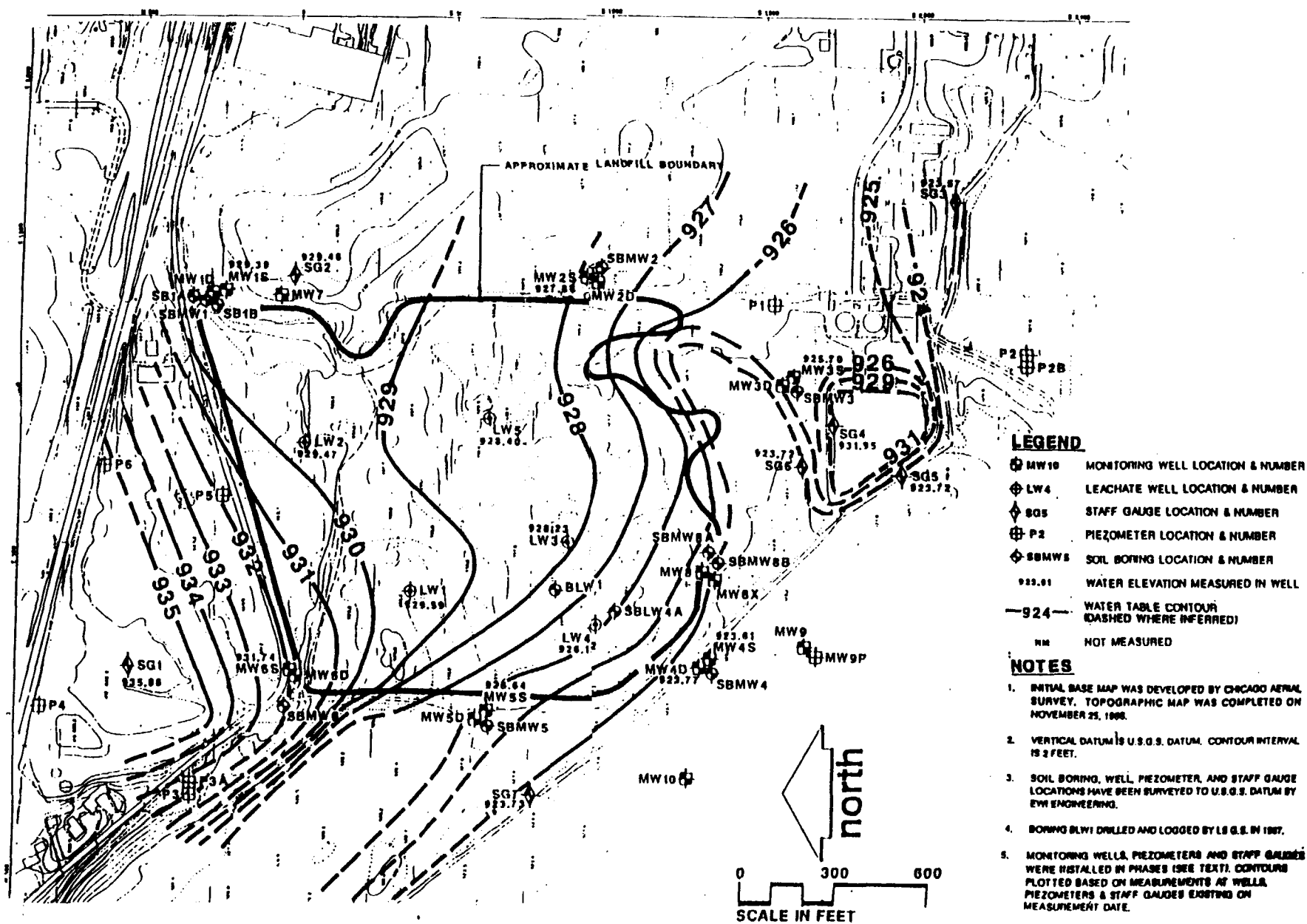


Figure 3. Private wells around the Woodstock Municipal Landfill (Warzyn, Inc., 1992).

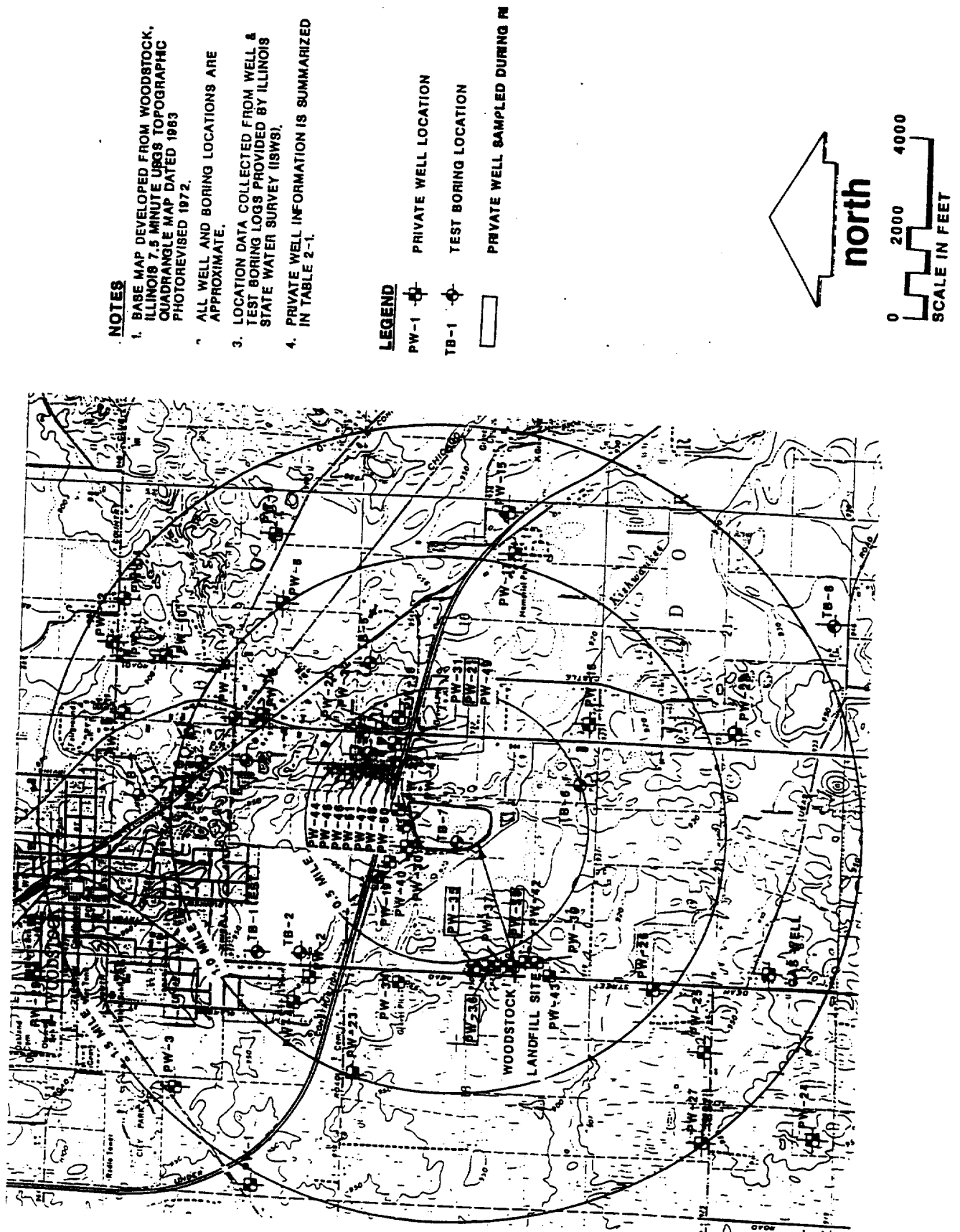
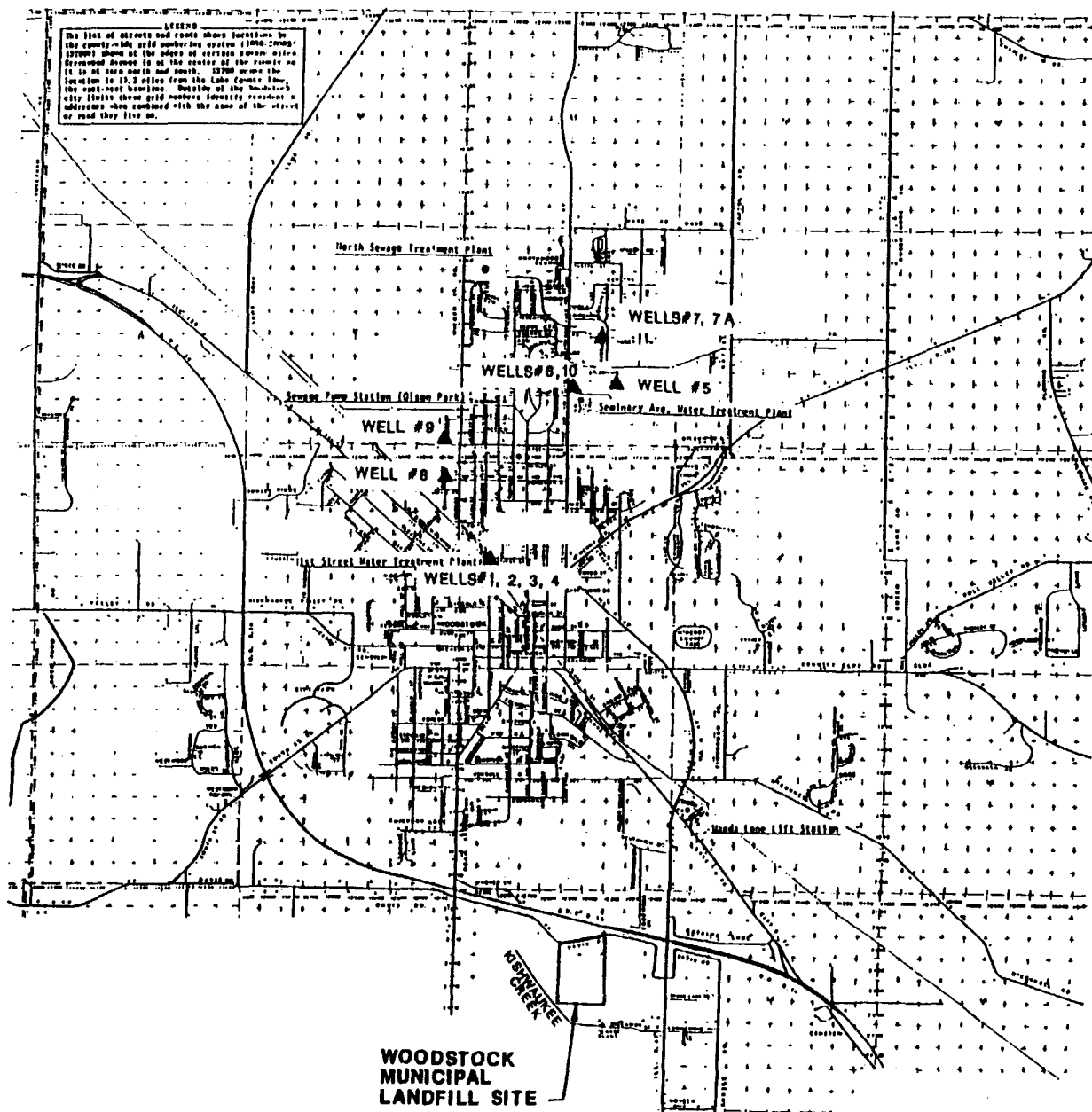


Figure 4. The locations of the Woodstock municipal wells (Marzyn, Inc., 1992).



APPENDIX B. TABLES

Table 1. Chemicals in landfill gas, November 7, 1990 (Warzyn, Inc., 1992).

Chemical	Concentration (ppb)
Benzene	N.D.-220
Chlorobenzene	N.D.-120
1,2,4-Trimethylbenzene	25-320
1,3,5-Trimethylbenzene	N.D.-70
Xylenes (total)	20-440

Table 2. Chemicals in leachate from the Woodstock Municipal Landfill, August 8, 1990 to February 8, 1991 (Warzyn, Inc., 1992).

Chemical	Concentration (ppb)
Volatile Organic Compounds	
Benzene	3-14
Semi-volatile Organic Compounds	
1,4-Dichlorobenzene	N.D.-8
4-Methylphenol	N.D.-2
Naphthalene	N.D.-34
Pentachlorophenol	N.D.-3
Inorganic Compounds	
Ammonia	3,460-51,800
Antimony	N.D.-30
Arsenic	N.D.-102
Barium	810-10,800
Beryllium	N.D.

N.D. = Not detected.
ppb = Parts per billion.

**Table 2, continued. Chemicals in leachate from the Woodstock Municipal Landfill,
August 8, 1990 to February 8, 1991 (Warzyn, Inc., 1992).**

Chemical	Concentration (ppb)
Cadmium	N.D.-333
Chromium	86-1,400
Copper	497-10,800
Lead	N.D.-18,000
Manganese	5,400-31,200
Mercury	0.28-5.7
Nickel	846-15,000
Selenium	N.D.-20.6
Silver	N.D.-58
Thallium	4.4-15.3
Vanadium	94-1,320
Zinc	8,140-185,000

N.D. = Not detected.
ppb = Parts per billion.

Table 3. Chemicals of concern in on-site shallow monitoring wells, October 30, 1990 to April 2, 1991 (Warzyn, Inc., 1992).

Chemical	Background Concentration (ppb)	Downgradient Concentration (ppb)	Comparison Value (ppb)	Source of Comparison Value
Volatile Organic Compounds				
Benzene	N.D.-5	N.D.-4	1	CREG
Semi-Volatile Organic Compounds				
bis(2-Ethylhexyl) phthalate	N.D.	N.D.-5	3; 200	CREG; EMEG
Inorganic Compounds				
Ammonia	N.D.-8,960	240-17,600	3,000	Intermediate EMEG
Arsenic	N.D.-19.2	N.D.-9.6	0.02; 3	CREG; RMEG
Manganese	92-827	202-1,090	50	RMEG

N.D. = Not detected.

ppb = Parts per billion.

CREG = Cancer Risk Evaluation Guide.

EMEG = Environmental Media Evaluation Guide.

RMEG = Reference Dose Media Evaluation Guide.

Table 4. Chemicals of concern in on-site deep monitoring wells, October 30, 1990 to April 2, 1991 (Warzyn, Inc., 1992).

Chemical	Background Concentration (ppb)	Downgradient Concentration (ppb)	Comparison Value (ppb)	Source of Comparison Value
Volatile Organic Compounds				
Benzene	N.D.-2	N.D.	1	CREG
Vinyl Chloride	N.D.	N.D.-21	*	--
Inorganic Compounds				
Ammonia	320-2,100	430-5,210	3,000	Intermediate EMEG
Antimony	N.D.	N.D.-6.8	4	RMEG
Arsenic	N.D.	N.D.-4.4	0.02; 3	CREG; RMEG
Manganese	163-403	48-529	50	RMEG

N.D. = Not detected.

ppb = Parts per billion.

CREG = Cancer Risk Evaluation Guide.

EMEG = Environmental Media Evaluation Guide.

RMEG = Reference Dose Media Evaluation Guide.

Table 5. Concentrations of chemicals in on- and off-site sediments, September 6, 1990 to April 3, 1991 (Warzyn, Inc., 1992).

Chemical	Background Marsh Concentration (ppm)	On-site Marsh Concentration (ppm)	Background Kishwaukee Creek Concentration (ppm)	Downstream Kishwaukee Creek Concentration (ppm)	Comparison Value (ppm)	Source of Comparison Value	Illinois ¹ Soil Background (ppm)	Eastern U.S. ² Background Soil (includes Illinois; ppm)
Semi-volatile Organic Compounds								
4-Methylphenol	--	N.D.-0.18	--	--	*	--	--	--
Inorganic Compounds								
Arsenic	5.5-12.5	2.3-24	11.1-12.9	7.3-12.8	0.5; 0.6	CREG; EMEG	N.D.-24	N.D.-73
Barium	97.3-161	46.8-316	112-152	165-172	100	RMEG	N.D.-1720	10-1500
Chromium	N.D.-17.6	8.9-41.4	8.6-9.9	13.2-18.2	10	RMEG	N.D.-151	1-1000
Lead	42.1-450	11.3-109	72.8-73.0	18.7-58.3	--	--	4.7-647	N.D.-300
Manganese	181-1,260	147-747	148-152	270-293	300	RMEG	61.5-5510	N.D.-7000
Nickel	N.D.-16.8	N.D.-274	N.D.	16.9-28.5	*; 40	RMEG	N.D.-135	N.D.-700
Thallium	N.D.	N.D.-3.7	N.D.	N.D.	--	--	0.02-2.8	--
Vanadium	N.D.-26.1	N.D.-37.6	N.D.	N.D.	o	Intermediate EMEG	N.D.-800	N.D.-300
Zinc	53.7-153	42.7-806	108-140	87.8-513	600	RMEG	N.D.-798	N.D.-2900

* = Suspected or known carcinogen, no slope factor available.

-- = Data not available.

N.D. = Not detected.

ppm = Parts per million.

CREG = Cancer Risk Evaluation Guide.

EMEG = Environmental Media Evaluation Guide.

RMEG = Reference Dose Media Evaluation Guide.

¹IEPA, 1994.

²Shacklette and Boerger, 1984.

**Table 6. Concentrations of chemicals in on-site surface soil from the Woodstock Municipal Landfill.
August 8, 1990 (Warzyn, Inc., 1992).**

Chemical	Concentration (ppm)	Comparison Value (ppm)	Source of Comparison Value	Illinois Soil ¹ Background (ppm)	Eastern U.S. ² Soil Background (ppm)
Semi-volatile Organic Compounds					
Benzo(a)anthracene	N.D.-0.160	*	--	--	--
Benzo(b)fluoranthene	N.D.-0.690	*	--	--	--
Benzo(k)fluoranthene	N.D.-0.690	*	--	--	--
Benzo(g,h,i)perylene	N.D.-0.110	--	--	--	--
Benzo(a)pyrene	N.D.-0.170	0.1	CREG	--	--
Butylbenzyl phthalate	N.D.-0.290	*: 400	RMEG	--	--
Chrysene	N.D.-0.180	*	--	--	--
Dibenz(a,h)anthracene	N.D.-0.048	*	--	--	--
Dimethylphthalate	N.D.-0.1	--	--	--	--
Indeno(1,2,3-c,d)pyrene	N.D.-0.100	*	--	--	--
Phenanthrene	N.D.-0.079	--	--	--	--
Inorganic Compounds					
Arsenic	3.3-5.1	0.5; 0.6	CREG; EMEG	N.D.-24	N.D.-73
Barium	40.4-412	100	RMEG	N.D.-1720	10-1500
Cadmium	N.D.-2.3	1	EMEG	N.D.-8.2	--
Chromium	5.8-75.1	10	RMEG	N.D.-151	1-1000
Lead	17.4-73.6	*	--	4.7-647	N.D.-300
Manganese	280-793	300	RMEG	61.5-5510	N.D.-7000
Nickel	11.6-51.5	*: 40	RMEG	N.D.-135	N.D.-700
Silver	N.D.-10.3	10	RMEG	N.D.-5.9	--
Vanadium	N.D.-15.5	6	Intermediate EMEG	N.D.-80	N.D.-300
Zinc	54.6-688	600	RMEG	N.D.-798	N.D.-2900

* = Suspected or known carcinogen, no slope factor available.

-- = Data not available.

N.D. = Not detected.

ppm = Parts per million.

CREG = Cancer Risk Evaluation Guide.

EMEG = Environmental Media Evaluation Guide.

RMEG = Reference Dose Media Evaluation Guide.

¹TEPA, 1994.

²Shacklette and Boerngen, 1984.

Table 7. Chemicals found in an on-site buried drum in the Woodstock Municipal Landfill, July 24, 1991 (Warzyn, Inc., 1992).

Chemical	Concentration (ppm)
Volatile Organic Compounds	
Acetone	17,000-730,000
Benzyl alcohol	21-300
1,2- Dichloro- benzene	12-300
Ethylbenzene	340
4-Methyl-2- pentanone	3,800-15,000
Toluene	22,000-87,000
Xylenes	310-1,400
Semi-volatile Organic Compounds	
bis(2-Ethylhexyl) phthalate	76-250
Di-N-butyl phthalate	100-120
Isophorone	6,000-46,000
Polychlorinated Biphenyls	
Aroclor 1254	120,000-140,000
Inorganic Compounds	
Mercury	N.D.-0.150

N.D. = Not detected.

ppm = Parts per million.

Table 8. Concentrations of chemicals in on- and off-site surface water, September 6, 1990 to April 3, 1991 (Warzyn, Inc., 1992).

Chemical	On-site Marsh Concentration (ppb)	Background Kishwaukee Creek Concentration (ppb)	Downstream Kishwaukee Creek Concentration (ppb)	Comparison Value (ppb)	Source of Comparison Value
Inorganic Compounds					
Arsenic	N.D.-2.4	N.D.	N.D.	0.02; 3	CREG; RMEG
Lead	4.6-5.3	N.D.	N.D.	*	--
Manganese	615-641	52-54.5	64-86.5	50	RMEG
Nickel	121-141	N.D.	N.D.	*; 200	RMEG

* = Suspected or known carcinogen, no slope factor available.

-- = Data not available.

N.D. = Not detected.

ppb = Parts per billion.

CREG = Cancer Risk Evaluation Guide.

RMEG = Reference Dose Media Evaluation Guide.

Table 9. Industrial emissions of reportable quantities of chemicals in Woodstock zip code 60098 (TRI, 1993).

Chemical	Environmental Medium	1987 (pounds)	1988 (pounds)	1989 (pounds)	1990 (pounds)	1991 (pounds)
Acetone	Air	46,750	49,370	36,970	13,436	N.R.
Aluminum oxide	Air	250	250	N.R.	N.R.	N.R.
Chlorine	Air	1000	1,000	1,000	1,000	N.R.
Copper	Air	N.R.	500	500	260	10
Manganese	Air	N.R.	N.R.	N.R.	10	10
Methyl ethyl ketone	Air	12,300	20,400	5,290	2,650	N.R.

N.R. = Quantity not reportable.

Table 9, continued. Industrial emissions of reportable quantities of chemicals in Woodstock zip code 60098 (TRI, 1993).

Chemical	Environmental Medium	1987 (pounds)	1988 (pounds)	1989 (pounds)	1990 (pounds)	1991 (pounds)
Nickel	Air	250	500	500	260	10
Nitric acid	Air	250	250	250	250	N.R.
Sodium hydroxide	Air	500	N.R.	N.R.	N.R.	N.R.
Sulfuric acid	Air	500	500	500	500	N.R.
Toluene	Air	52,000	29,000	19,000	13,000	17,111
1,1,1-Trichloroethane	Air	N.R.	250	750	750	750
Acetone	Water	N.R.	N.R.	N.R.	5	N.R.
Chlorine	Water	750	750	750	750	N.R.
Copper	Water	N.R.	250	250	250	N.R.
Methyl ethyl ketone	Water	N.R.	N.R.	N.R.	5	N.R.
Nickel	Water	250	250	250	250	N.R.
Sodium hydroxide	Water	250	N.R.	N.R.	N.R.	N.R.

N.R. = Quantity not reportable.

Table 10. Concentrations of chemicals in off-site private wells, July 24, 1990 (Warzyn, Inc., 1992).

Chemical	Concentration (ppb)	Comparison Value (ppb)	Source of Comparison Value
Inorganic Compounds			
Arsenic	N.D.-2.6	0.02; 3	CREG; RMEG
Manganese	N.D.-119	50	RMEG

N.D. = Not detected.

ppb = Parts per billion.

CREG = Cancer Risk Evaluation Guide.

RMEG = Reference Dose Media Evaluation Guide.

Table 10, continued. Sources of contamination, environmental transport pathways, exposure pathways, and possible receptors.

B. Potential Pathways

Source of Contamination	Environmental Transport Pathways	Exposure Pathways	Possible Receptors	Time
Woodstock Municipal Landfill	Surface water	Dermal contact	On-site workers, Trespassers, Nearby residents, Future on-site residents	Past, Present, Future
Woodstock Municipal Landfill	Biota	Ingestion	Hunters, Future on-site residents	Past, Present, Future

Table 11. Sources of contamination, environmental transport pathways, exposure pathways, and possible receptors.

A. Completed Pathways

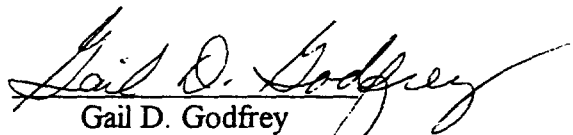
Source of Contamination	Environmental Transport Pathways	Exposure Pathways	Possible Receptors	Time
Woodstock Municipal Landfill	Surface soil	Dermal contact Ingestion	Trespassers, On-site workers, Future on-site residents	Past Present Future

B. Potential Pathways

Source of Contamination	Environmental Transport Pathways	Exposure Pathways	Possible Receptors	Time
Woodstock Municipal Landfill	Air	Dermal contact, Inhalation, Ingestion (dust)	On- and off-site workers, Nearby residents, Trespassers, Future on-site residents	Past, Present, Future
Woodstock Municipal Landfill	Groundwater	Dermal contact, Inhalation, Ingestion	Users of off-site private wells	Future
Woodstock Municipal Landfill	Sediments	Dermal contact Ingestion	On-site workers, Trespassers, Nearby residents, Future on-site residents	Past, Present, Future

CERTIFICATION

This Woodstock Landfill Public Health Assessment was prepared by the Illinois Department of Public Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health assessment was begun.



Gail D. Godfrey
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Superfund Site Assessment Branch (SSAB)
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ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health assessment and concurs with its findings.



Richard E. Gillig
Chief, SPS, SSAB, DHAC, ATSDR